Schooling individuals discover a novel food source via social learning faster than non-schooling individuals

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Introduction

Novel information, such as the location of a new food source, can be transmitted throughout a group via social learning, as opposed to direct sampling of the environment. When learning is asocial, individuals will encounter a novel food source on their own, with no guidance from others. However, in a social learning environment, individuals will learn of a novel food source by directly observing others.

Schooling or flocking behavior, which is often seen in fish and birds, also allows for social learning to occur, due to the close proximity individuals have with one another in their group.

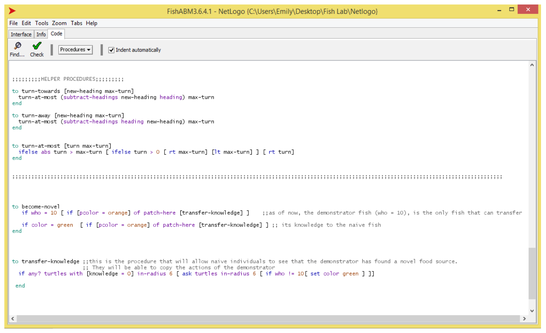
The purpose of our models was to determine if a schooling behavior could affect the rate at which a population of individuals learned the location of a novel food source.

Hypothesis

Individuals that are in a group where learning is social and schooling occurs will learn the location of a novel food source faster than compared to individuals in groups that are asocial with no schooling

Methods

The agent based model, Netlogo, was used to allow individuals to move around in an artificial environment.

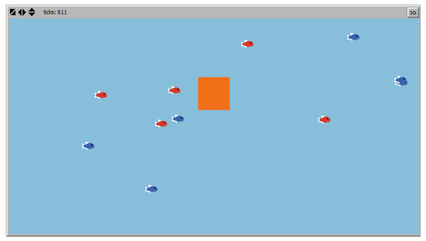


Three models were created:

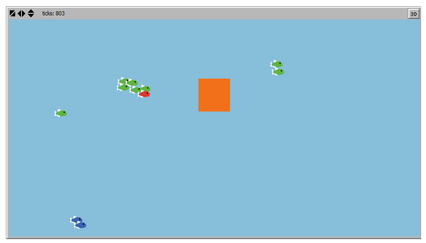
1. Learning is asocial and movement is random
2. Learning is social and there is schooling
3. Learning is social and movement is random

As the agents interacted with each other over time, the information about the novel food source, represented as an orange square in the models, was passed to others in the group and the ending number of ticks, or timesteps, was recorded.

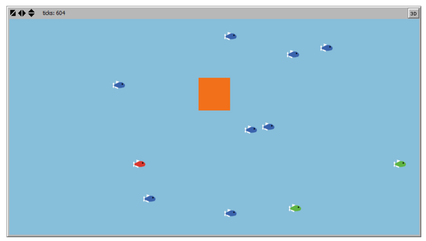
Methods (cont.)



Learning is asocial and movement is random-
An individual will learn of the new food source only by swimming directly over the orange food patch. There is no communication about the food patch from others. Movement is random, with no schooling.

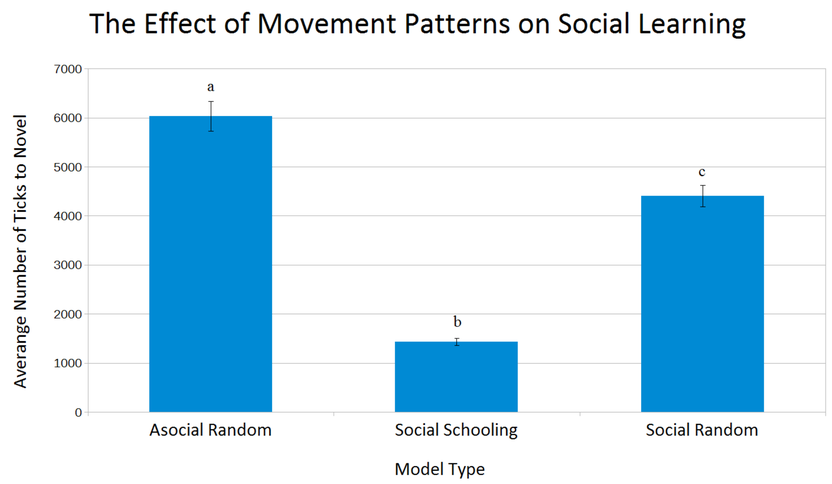


Learning is social and schooling occurs-
Individual fish must learn about the location of the new food patch from a fish that already has that information.
The red fish begins with knowledge of the novel food source. When it is within a certain radius of the food source it will share the novel information with an uninformed individual, represented as a blue fish. As soon as the novel information is shared, the uninformed fish will become informed and change color to green. It can now pass along information about the food source to other uninformed fish. Individuals in this model will school together in tight groups.



Learning is social and movement is random-
In this model, fish must still learn about the new food source from other individuals, but there is no schooling behavior and movement is random. A fish that knows the location of the new food source can still pass on that information by being within a certain radius of the food patch and the uninformed fish.

Results



Results (cont.)

The fastest population, on average, to obtain the novel information about the food patch was in the model where learning was social and schooling occurred. The population that took the longest, on average, to learn the location of the food patch was in the model where learning was asocial and movement was random.

A two-tailed Mann-Whitney U test was performed to analyze the difference between each of the three models. In all three comparisons, the pairwise tests were significant, showing there is a statistical difference between each model.
Asocial Random vs. Social Random ($U=2060$, $p<.001$, $df=998$)
Asocial Random vs. Social Schooling ($U=44251$, $p<.001$, $df=998$)
Social Random vs. Social Schooling ($U=218009$, $p<.001$, $df=998$)

Other studies have found that individuals in a group will find a new food patch sooner if other group members have previously done so. (Atton et al 2012) This relates to the tendency of fish to school. Because they are grouped so close together, it is not surprising to see that individuals in schools will transmit novel information between each other at a faster rate than if they are farther apart and non-schooling.

Conclusions

Individuals learn the location of a new food source at a much faster rate when learning is social and the individuals are schooling together. In schooling populations, information about the new food source was shown to be transferred more quickly from individual to individual when compared to a model where movement was random and learning asocial.

Acknowledgements / Citations

Atton N, Hoppitt W, Webster MM, Galef BG, Laland KN. 2012. Information flow through threespine stickleback networks without social transmission. *Proc. R. Soc. B.* **279,** 4272-4278.

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